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CLAIMS

What is Claimed is:

1. A system for estimating a tongue length of a trailer being towed by a vehicle, said vehicle including a pair of front wheels and a pair of rear wheels, said system comprising:

a front wheel steering angle sensor for providing a front wheel steering angle signal indicative of the angle of the front wheels of the vehicle;

a vehicle speed sensor for providing a vehicle speed signal indicative of the speed of the vehicle;

a vehicle yaw rate sensor for providing a vehicle yaw rate signal indicative of the yaw rate of the vehicle;

a trailer yaw rate sensor for providing an actual trailer yaw rate signal indicative of the yaw rate of the trailer; and

a tongue length estimation controller for calculating the estimate of the tongue length, said estimation controller calculating the estimate of the tongue length based on an initial trailer tongue length, the front wheel angle signal, the vehicle yaw rate signal, the vehicle speed signal and the actual trailer yaw rate signal.

2. The system according to claim 1 wherein the estimation controller calculates an estimated trailer yaw rate and compares the estimated trailer yaw rate to the actual trailer yaw rate signal to generate a yaw rate error signal therefrom.

3. The system according to claim 2 wherein the tongue length estimation controller converts the yaw rate error signal to a tongue length error signal.

4. The system according to claim 3 wherein the estimation controller includes a PID controller, said PID controller converting the yaw rate error signal to the tongue length error signal.

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5. The system according to claim 3 wherein the estimation controller includes a comparator for comparing the tongue length error signal to an initial tongue length estimation signal to generate a corrected tongue length estimation signal.

6. The system according to claim 1 further comprising a rear wheel steering angle sensor for providing a rear wheel steering angle signal indicative of the angle of the rear wheels of the vehicle, said tongue length estimation controller calculating the estimate of the tongue length of the trailer based on all of the front wheel angle signal, the rear wheel angle signal, the vehicle yaw rate signal, the vehicle speed signal and the actual trailer yaw rate signal.

7. The system according to claim 6 wherein the rear wheels of the vehicle are automatically controlled by a rear wheel steering controller in the vehicle.

8. The system according to claim 1 wherein the tongue length estimation controller does not calculate the estimate of the tongue length until certain initial conditions are met, said initial conditions including a certain vehicle speed, a certain vehicle yaw rate and a certain trailer yaw rate.

9. The system according to claim 8 wherein the initial conditions include a vehicle speed greater than 0.05 kilometers per hour, a vehicle yaw rate greater than 0.005 degrees per second and a trailer yaw rate greater than 0.005 degrees per second.

10. The system according to claim 1 wherein the system is used in connection with a coordinated front and rear wheel steering system.

11. A system for estimating a tongue length of a trailer being towed by a vehicle, said vehicle including a pair of front wheels and a pair of rear wheels,

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where the front wheels are steered by an operator and the rear wheels are automatically steered by an on-board steering controller, said control system comprising:

- a front wheel steering angle sensor for providing a front wheel steering angle signal indicative of the angle of the front wheels of the vehicle;

- a rear wheel steering angle sensor for providing a rear wheel steering angle signal indicative of the angle of the rear wheels of the vehicle;

- a vehicle speed sensor for providing a vehicle speed signal indicative of the speed of the vehicle;

- a vehicle yaw rate sensor for providing a vehicle yaw rate signal indicative of the yaw rate of the vehicle;

- a trailer yaw rate sensor for providing an actual trailer yaw rate signal indicative of the yaw rate of the trailer; and

- a tongue length estimation controller for calculating the estimate of the tongue length of the trailer, said estimation controller calculating an estimated trailer yaw rate based on the front wheel angle signal, the rear wheel angle signal, the vehicle yaw rate signal and the vehicle speed signal, said tongue length estimation controller including a first comparator for comparing the estimated trailer yaw rate to the actual trailer yaw rate signal to generate a yaw rate error signal, said estimation controller further including a PID controller that is responsive to the yaw rate error signal, said PID controller converting the yaw rate error signal to a tongue length error signal, said estimation controller further including a second comparator for comparing the tongue length error signal to an initial tongue length estimation signal to provide a corrected tongue length estimation signal.

12. The system according to claim 11 wherein the tongue length estimation controller does not compute the estimate of the tongue length until certain initial conditions are met, said initial conditions including a certain vehicle speed, a certain vehicle yaw rate and a certain trailer yaw rate.

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13. The system according to claim 12 wherein the initial conditions include a vehicle speed greater than 0.05 kilometers per hour, a vehicle yaw rate greater than 0.005 degrees per second and a trailer yaw rate greater than 0.005 degrees per second.

14. A system comprising:
a vehicle including at least one front wheel and at least one rear wheel, said vehicle further including a vehicle hitch post;
a trailer including at least one trailer wheel, said trailer further including a trailer hitch post;
a hitch coupling the vehicle hitch post to the trailer hitch post;
a trailer yaw rate sensor for providing an actual trailer yaw rate signal indicative of the yaw rate of the trailer; and
a controller, said controller calculating a tongue length of the trailer based on the actual trailer yaw rate signal.

15. The system according to claim 14 wherein the controller calculates an estimated trailer yaw rate and compares the actual yaw rate signal to the estimated trailer yaw rate, said estimated trailer yaw rate being calculated by an algorithm from inputs including the angle of the vehicle's front wheel, the angle of the vehicle's rear wheel, the yaw rate of the vehicle and the speed of the vehicle.

16. A method of estimating a tongue length of a trailer being towed by a vehicle, said method comprising:
determining the angle of front wheels of the vehicle;
determining the speed of the vehicle;
determining the yaw rate of the vehicle;
determining the actual yaw rate of the trailer; and
calculating the estimate of the tongue length of the trailer based on the front wheel angle, the vehicle yaw rate, the vehicle speed and the actual trailer yaw rate.

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17. The method according to claim 16 further comprising determining the angle of rear wheels of the vehicle, wherein calculating the tongue length includes calculating the estimate of the tongue length based on the front wheel angle, the rear wheel angle, the vehicle yaw rate, and the vehicle speed.

18. The method according to claim 16 wherein calculating the estimate of the tongue length includes calculating an estimated trailer yaw rate and comparing the estimated trailer yaw rate to the actual trailer yaw rate to generate a yaw rate error signal.

19. The method according to claim 18 wherein calculating the estimate of the tongue length includes converting the yaw rate error signal to a tongue length error signal.

20. The method according to claim 19 wherein calculating the estimate of the tongue length includes comparing the tongue length error signal to an initial tongue length estimation signal to generate a corrected tongue length estimation.